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(54) Apparatus and method for providing consistent, non-jamming registration of notched semiconductor wafers.

(57) An apparatus (40) for providing consistent, non-jamming registration of a notched semiconductor wafer (46) undergoing multiple sequential process work includes a plate (41) upon which the wafer (46) is laid flat. The notch (45) of the notched semiconductor wafer (46) is registered against a first roller (42) that is fixedly mounted to the plate (41). A second roller (43), also fixedly mounted to the plate (41), registers a first point (47) along the circumference of the wafer (46). A third roller (48) is fixedly mounted to a bracket (50) that is movable approximately along the radius of the wafer (46). A force (52) is applied to this bracket (50) resulting in the third roller (48) applying a force against the wafer (46). This resultant force, coupled with the rotating capability of the rollers (42,43,48), allows the wafer (46) to rotate into a proper registration position.

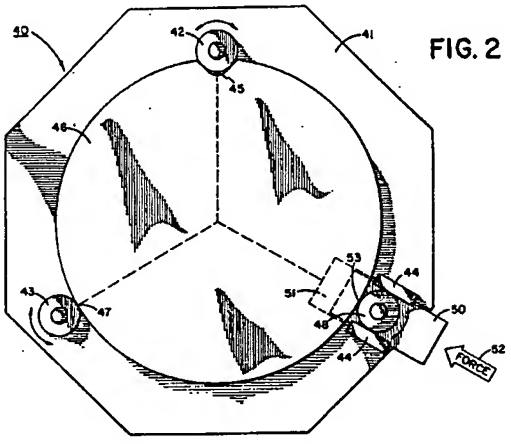

FIG. 2

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BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to the registration of semiconductor wafers undergoing multiple sequential processes, such as a metrology step followed by a thinning and/or etching processes and, in particular, relates to a apparatus that provides consistent, non-jamming registration of notched semiconductor wafers in order to correlate the registration of the semiconductor wafers throughout the multiple sequential processes.

Description of the Prior Art

The process of measuring the thickness of an outer material layer of a semiconductor wafer is known as wafer surface metrology. During such a wafer surface metrology process, a semiconductor wafer is mechanically registered to the stage of a thickness measuring instrument. This instrument generates a map that indicates the thickness of a outer material layer of the wafer over an entire surface of the wafer. The outer layer thickness map generated from this metrology process is often used in other processes that thin or etch the material of the outer layer of the wafer to a desired thickness or in a desired location, respectively. These outer layer thinning and etching processes both include some type of tool that is directed onto the surface of the wafer. This tool must be properly positioned along the wafer surface to ensure that the thinning or etching process is performed at the correct location on the wafer surface. To ensure this proper wafer registration, an accurate correlation between the outer layer thickness map and the position of the wafer with respect to the thinning or etching tool is required.

For semiconductor wafers having flats, a current approach for correlating an outer layer thickness map with the position of the wafer in a thinning or etching instrument begins by marking the wafer with a set of alignment fiducials during the metrology process. The wafer is then placed on a larger diameter wafer which serves as a surround. The surround is made of the same material as the wafer undergoing work to maintain a consistent reaction in the thinning or etching process along the wafer edge. The flat of the fiducialized wafer is abutted to a flat registration surface of like wafer material that is taped to the surface of the surround, thereby registering the wafer in one direction. The wafer metrology fiducials are then visually aligned with a corresponding set of scribe marks on a aluminum holding plate, or platen, of the instrument. Once aligned, two additional registration surfaces of like wafer material are abutted against the wafer and taped to the surround to maintain the wafer position. The surround is then taped to the platen so that the thinning or etching process may begin.

It is easily seen that the above-described correlated registration procedure can be time consuming and prone to human error. Furthermore, the above-described procedure does not allow for the correlated registration of notched semiconductor wafers. It is therefore desirable to provide a correlated registration apparatus and procedure that is less time consuming and less prone to human error than the above-described procedure, and that allows correlated registration of notched semiconductor wafers.

Such a desirable correlation registration procedure is achievable with an apparatus, described more thoroughly hereinafter in the detailed description, that is presently used to provide consistent registration of notched semiconductor wafers in metrology and thinning and etching instruments. A disadvantage of this presently used apparatus, however, is that jamming can occur due to friction between the surfaces of the wafer to be registered and the registration surfaces of the apparatus. Thus, it is further desirable to prevent such jamming in this presently used apparatus.

SUMMARY OF THE INVENTION

The present invention contemplates an apparatus that provides consistent registration of notched semiconductor wafers and provides correlation between thinning and etching processes and metrology process data. Such an apparatus is comprised of a metal mounting plate upon which a notched wafer undergoing work lays flat. The wafer is partially registered to the metal plate by two rollers that are fixedly mounted to the plate. The first of these fixedly mounted rollers is positioned on the metal plate such that, when the wafer is properly registered, both walls of the wafer notch are abutted against this roller. The second of these fixedly mounted rollers is positioned on the metal plate such that the wafer, when properly registered, is abutted against this roller at a point on the wafer approximately -120° from the wafer notch. Proper registration is ensured by a third, adjustable roller that is fixedly mounted on a moveable metal bracket which allows the roller to move in an approximately radial direction with respect to the wafer. This third, adjustable roller applies a force against the wafer, at a point on the wafer approximately 120° from the wafer notch, by way of a external force applied to the moveable metal bracket. This force, coupled with the rolling capability of the rollers, ensures that an initially improperly registered wafer will be rotated into the proper registra-

tion position. Also, due to the fact that the rollers, by virtue of having rolling element bearings, generally exhibit only a slight amount of friction, or a rolling friction, the effective coefficient of friction between the rollers and the wafer is significantly less than a critical value in the effective coefficient of friction above which wafer jamming occurs. Thus, the wafer will be properly registered without jamming.

It should be noted that unlike the prior art, where the registration surfaces and the surround are fabricated from the same material as the wafer undergoing work, the rollers and associated mounting plate of the present invention are not subject to this same material constraint. As previously described, this constraint is required in the prior art so that consistent thinning and etching processes are maintained along the wafer edge. Although this material constraint does fulfill the object of maintaining consistent processes, a undesirable result of increased material replacement occurs since the thinning and etching processes depreciatively affect the registration and surround materials.

The material constraint and resulting material replacement problems of the prior art are overcome in the present invention by shielding the rollers and the associated mounting plate from the depreciative affects of the thinning and etching processes. Thus, the materials used in the present invention apparatus can be selected with practical considerations such a cost and reliability in mind, instead of impractical and costly material constraints.

The present invention apparatus described above can be used in thinning, etching, and metrology processes, among others, and provides consistent non-jamming registration of notched semiconductor wafers undergoing process work regardless of diameter variations among processed wafers. Furthermore, the use of this apparatus can decrease the registration time associated with the tedious visual alignment procedures of the prior art, while minimizing the potential for human error.

Accordingly, the primary object of the present invention is to provide an apparatus that provides consistent, non-jamming registration of notched semiconductor wafers.

Another object of the present invention is to provide an apparatus that can accurately correlate metrology process data to wafer registration in thinning and etching process instruments.

Another object of the present invention is to provide an apparatus that decreases wafer registration time as compared to prior art registration procedures.

Other object and advantages of the present invention will become apparent to those skilled in the art from the following detailed description of the invention read in conjunction with the appended claims and the drawings attached hereto.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to facilitate a fuller understanding of the present invention, reference is now made to the drawings. These drawings, are not drawn to scale and should not be construed as limiting the present invention, but are intended to be exemplary only.

Figure 1 is a plan view of a prior art notched semiconductor wafer registration apparatus that is experiencing wafer jamming.

Figure 2 is plan view of a notched semiconductor wafer registration apparatus embodying the principles of the present invention wherein rollers are used to consistently register notched semiconductor wafers.

DETAILED DESCRIPTION OF THE INVENTION

Referring to Figure 1, there is shown a prior art notched semiconductor wafer registration apparatus **10**, the use of which can result in wafer-jamming. This prior art apparatus **10** maintains a surround **12** upon which two registration surfaces **14, 15** and two guides **24** are fixedly mounted. The first **14** of the two **14,15** fixedly mounted registration surfaces is used for registering a notch **18** of a wafer **16**. The second **15** of the two **14, 15** fixedly mounted registration surfaces is positioned to register a point **20** on the wafer **16** approximately -120° from the wafer notch **18**.

A third, adjustable registration surface **22** is placed between the two fixedly mounted guides **24**. In order to securely constrain the wafer **16** a force **26** is applied to this third, adjustable registration surface **22**, and hence to the wafer **16**. This force **26** tends to rotate the wafer **16** about a virtual pivot **28** until contact is made with all of the registration surfaces **14,15,22**. However, friction at the points of contact between the wafer **16** and the registration surfaces **14,15,22** tends to impede this necessary rotation. In fact, a critical value in the effective coefficient of friction between the wafer **16** and the registration surfaces **14,15,22** exists above which the necessary rotation does not occur regardless of the magnitude of the applied force **26**. This results in a friction jam that causes the wafer **16** to be improperly registered as shown.

Referring to Figure 2, there is shown a notched semiconductor wafer registration apparatus **40** according to the present invention that overcomes the previously mentioned friction-jamming problems of the prior art. This apparatus **40** maintains an aluminum plate **41** upon which two rollers **42,43**, and two guides **44** are fixedly mounted. The aluminum plate **41** also provides an area upon which a semi-

conductor wafer **46** can be laid flat. The first **42** of the two **42,43** fixedly mounted rollers is positioned on the plate **41** such that, when the wafer **46** is properly registered, both walls of the wafer notch **45** are abutted against this roller **42**. The second **43** fixedly mounted roller is positioned on the plate **41** such that the wafer **46**, when properly registered, is abuttted against this roller **43** at a point **47** on the wafer **46** approximately -120° from the wafer notch **45**.

A third, adjustable roller **48** is fixedly mounted to a sliding aluminum bracket **50** that is positioned between the two guides **44** and within a radial groove **51** that has been fabricated or milled into the aluminum plate **41**. As should be apparent from the figure to one with ordinary skill in the art, the purpose of the two guides **44** and the radial groove **51** is to restrict the sliding aluminum bracket **50**, and hence the third roller **48**, to an approximately radial movement with respect to the wafer **46**. Alternatively, the sliding aluminum bracket **50** can be replaced b a pivot arm adapted to pivot about a pivot pin mounted to the plate **41**.

To ensure proper wafer registration, a external force **52** is applied to the sliding aluminum bracket **50**. This externally applied force **52** results in the third roller **48** applying a similar force against the wafer **46** at a point **53** on the wafer approximately 120° from the wafer notch **45**. This resulting force, coupled with the rolling capability of the rollers **42, 43, 48**, ensures that an improperly registered wafer will be rotated into the proper registration position, a shown. Also, due to the fact that the rollers **42, 43, 48**, by virtue of having rolling element bearings, generally exhibit only a slight amount of friction, or a rolling friction, the effective coefficient of friction between the rollers **42, 43, 48** and the wafer **46** is significantly less than the critical value in the effective coefficient of friction above which wafer jamming occurs. Thus, the wafer **46** will be properly registered without jamming. Of course, proper registration will only occur when the wafer **46** is originally positioned on the plate **41** in a manner that will allow such registration; i.e. the wafer notch **45** must be in sufficiently close proximity to the first roller **42**. The present state of the art in wafer handling systems is such that this original positioning condition should be easily achieved.

It should be noted that although the apparatus **40** has been described herein with aluminum being the material of the plate **41** and the other associated components, other practical materials may also be used.

With the present invention notched semiconductor wafer registration apparatus **40** now fully described, it can thus be seen that the objectives set forth above are efficiently attained and, since certain changes may be made in the above described apparatus **40** without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

Claims

1. An apparatus for providing consistent, non-jamming registration of semiconductor wafers undergoing process work in a plurality of process instruments, wherein each said semiconductor wafer undergoing work has a notch formed along a portion of its circumference, said apparatus comprising:

   means for supporting a notched semiconductor wafer is registered;

   means for providing a registration that movably accommodates the notch of said notched semiconductor wafer;

   means for providing a registration that movably accommodates a first point along the circumference of said notched semiconductor wafer; and

   means for providing a registration that movably accommodates a second point along the circumference of said notched semiconductor wafer, such that said notch registration means, said first point registration means, and said second point registration means movably accommodate said notched semiconductor wafer via a force that is applied to said notched semiconductor wafer by said second point registration means as a result of an external force that is applied to said second point registration means.

2. The apparatus as defined in claim 1, wherein said supporting means comprises a plate having a surface upon which said notched semiconductor wafer is laid flat.

3. The apparatus as defined in claim 2, wherein said plate includes an approximately radial groove that assists in directing said applied force approximately along the radius of said notched semiconductor wafer.

4. The apparatus as defined in claim 3, wherein said plate is made of aluminum to withstand depreciative effects associated with said plurality of process instruments.

5. The apparatus as defined in claim 1, wherein said means for providing a registration to the notch of said notched semiconductor wafer comprises a roller, wherein said roller is fixedly mounted to said support means, and wherein

said roller movably accommodates said notch of said notched semiconductor wafer by having both walls of said notch abut against said roller and by allowing said notched semiconductor wafer to rotate into a proper registration position.

6. The apparatus as defined in claim 1, wherein said means for providing a registration to a first point along the circumference of said notched semiconductor wafer comprises a roller, wherein said roller is fixedly mounted to said support means, and wherein said roller movably accommodates said first point along the circumference of said notched semiconductor wafer by having said notched semiconductor wafer abut against said roller and by allowing said notched semiconductor wafer to rotate into a proper registration position.

7. The apparatus a defined in claim 6, wherein said first point along the circumference of said notched semiconductor wafer is approximately -120° from said wafer notch.

8. The apparatus as defined in claim 1, wherein said means for providing a registration to a second point along the circumference of said notched semiconductor wafer comprises a roller, wherein said roller is fixedly mounted to a bracket that is movable approximately along the radius of said notched semiconductor wafer such that an approximate radial force may be applied against said notched semiconductor wafer by said roller, and wherein said roller movably accommodates said second point along the circumference of said notched semiconductor wafer by having said notched semiconductor wafer abut against said roller as a result of said applied force and by allowing said notched semiconductor wafer to rotate into a proper registration position.

9. The apparatus as defined in claim 8, further comprising two guides, wherein said two guides are fixedly mounted to said support means, and wherein said two guides restrict said bracket to said approximate radial movement.

10. The apparatus as defined in claim 9, wherein said bracket and said guides are made of aluminum to withstand depreciative effects associated with said plurality of process instruments.

11. The apparatus as defined in claim 10, wherein said second point along the circumference of said notched semiconductor wafer is approximately 120° from said wafer notch.

FIG. 1
(PRIOR ART)

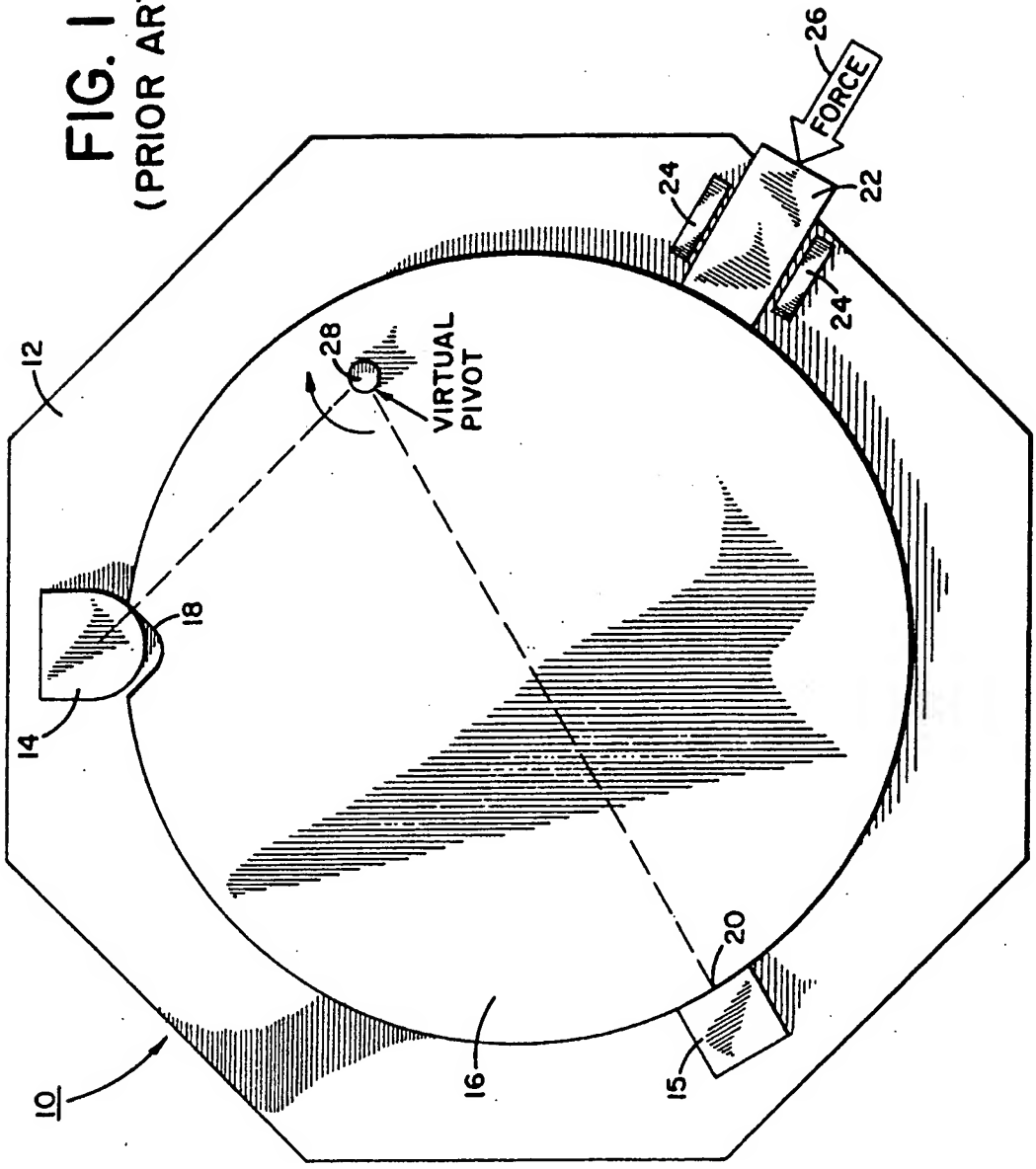
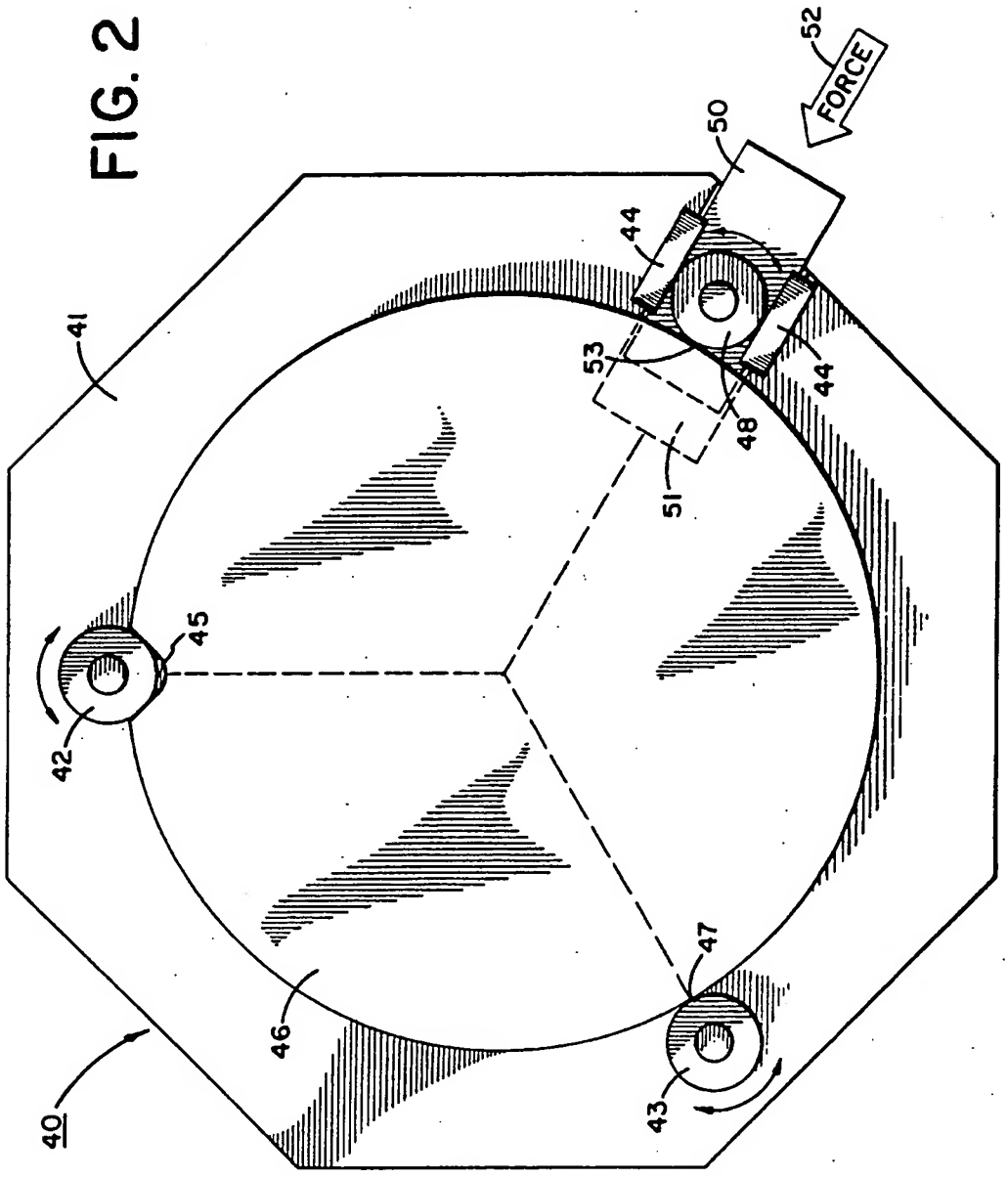


FIG. 2



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EUROPEAN SEARCH REPORT

Application Number
EP 94 10 5574

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
X Y	US-A-4 887 904 (CANON) * column 3, line 30 - column 4, line 56 *	1,2 3,4,8-11	H01L21/00
Y	US-A-4 820 930 (CANON) * column 2, line 60 - column 6, line 52 *	3,8,9,11	
Y	US-A-5 180 150 (HUGHES) * column 3, line 23 - line 25 *	4,10	

TECHNICAL FIELDS SEARCHED (Int.Cl.5)

H01L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	5 July 1994	Bertin, M

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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